CLAIMS

What is claimed is:

1. An horological device comprising:

a time cell, wherein the time cell has a substantially discharged state before a programming operation and has a controlled discharge state after the programming operation, and wherein the time cell transitions after the programming operation from the controlled discharge state to the substantially discharged state within a predetermined time period after the programming operation; and

circuitry connected to the time cell to allow reading a state of the time cell.

2. The horological device of claim 1 wherein a length of the predetermined time period varies with an initial condition of the time cell after the programming operation.

3. The horological device of claim 1 further comprising:

an array of time cells.

4. The horological device of claim 3 wherein at least one time cell in the array of time cells has a predetermined time period that differs from a predetermined time period of another time cell in the array of time cells.

5. The horological device of claim 3 wherein at least two time cells in the array of time cells have substantially identical predetermined time periods.

6. The horological device of claim 3 further comprising:

a time cell interface unit for controlling the array of time cells by initializing one or more time cells in the array of time cells.

7. The horological device of claim 3 further comprising:

a programming request processing unit for processing a programming request to set one or more time cells within the array of time cells.

8. A method for using an horological device, the method comprising:

programming a time cell, wherein the time cell has a substantially discharged state before a programming operation and has a controlled discharge state after the programming operation; and

discharging the time cell, wherein the time cell transitions after the programming operation from the controlled discharge state to the substantially discharged state within a predetermined time period after the programming operation.

9. The method of claim 8 wherein a length of the predetermined time period varies with an initial condition of the time cell after the programming operation.

10. The method of claim 8 further comprising:

programming at least one time cell in an array of time cells.

11. The method of claim 10 further comprising:

controlling the array of time cells through a time cell interface unit by initializing one or more time cells in the array of time cells.

12. The method of claim 10 further comprising:

processing a programming request to set one or more time cells within the array of time cells.

13. A computer program product on a computer readable medium for use in a data processing system for using an horological device, the computer program product comprising:

instructions for receiving a programming request to initialize the horological device; and

instructions for programming a time cell, wherein the time cell has a substantially discharged state before a programming operation and has a controlled discharge state after the programming operation, and wherein the memory cell transitions after the programming operation from the controlled discharge state to the substantially discharged state within a predetermined time period after the programming operation.

14. The computer program product of claim 13 wherein a length of the predetermined time period varies with an initial condition of the time cell after the programming operation.

15. The computer program product of claim 13 further comprising:

instructions for programming at least one time cell in an array of time cells.

16. The computer program product of claim 15 further comprising:

instructions for controlling the array of time cells through a time cell interface unit by initializing or reading one or more time cells in the array of time cells.

17. The computer program product of claim 15 further comprising:

instructions for processing a programming request to set one or more time cells within the array of time cells.

18. An horological device comprising:

a first mode of operation in which a memory cell has a stable memory state before a programming operation;

a second mode of operation in which the memory cell is programmed to transition from the stable memory state to a non-stable memory state;

a third mode of operation in which the memory cell has a non-stable memory state after the second mode of operation;

a fourth mode of operation in which the memory cell transitions from the non-stable memory state to the stable memory state within a predetermined time period; and

a fifth mode of operation in which the memory cell has a stable memory state after the predetermined time period.

19. The horological device of claim 18 wherein a length of the predetermined time period varies with an initial condition of the memory cell after the second mode of operation.

20. An horological device comprising:

maintaining means for maintaining a non-time-measuring state in the horological device without inputting energy into the horological device;

changing means for changing from the non-time-measuring state to a time-measuring state by receiving and storing an electrostatic charge in a charge storage element within the horological device, wherein the charge storage element comprises an internal medium for storing an electrostatic charge and an insulating medium for insulating the internal medium that substantially surrounds the internal medium; and

transitioning means for transitioning from the time-measuring state to the non-time-measuring state, without inputting energy into the horological device, by discharging the stored electrostatic charge in the charge storage element to a predetermined level of electrical potential within a predetermined time period after changing to the time-measuring state.

21. A method for using an horological device, the method comprising:

maintaining a non-time-measuring state in the horological device without inputting energy into the horological device;

changing from the non-time-measuring state to a time-measuring state by receiving and storing an electrostatic charge in a charge storage element within the horological device, wherein the charge storage element comprises an internal medium for storing an electrostatic charge and an insulating medium for insulating the internal medium that substantially surrounds the internal medium;

transitioning from the time-measuring state to the non-time-measuring state, without inputting energy into the horological device, by discharging the stored electrostatic charge in the charge storage element to a predetermined level of electrical potential within a predetermined time period after changing to the time-measuring state; and

detecting a current state of the charge storage element to determine an elapsed time.

22. An horological device comprising:

an internal medium for storing an electrostatic charge;

an insulating medium for insulating the internal medium, the internal medium and the insulating medium forming a charge storage element,

wherein the insulating medium substantially surrounds the internal medium;

wherein the insulating medium has physical properties that allow a charging process for charging the internal medium with an electrostatic charge through the insulating medium;

wherein the insulating medium has physical properties that allow a discharge process for discharging a stored electrostatic charge from the internal medium through the insulating medium;

wherein the insulating medium has one or more physical properties that affect a rate of discharge in the discharge process; and

wherein at least one physical property of the insulating medium has been selected so that the discharge process discharges a stored electrostatic charge at a predetermined discharge rate.

23. The horological device of claim 22 wherein the predetermined discharge rate is non-linear with respect to time.

24. The horological device of claim 22 wherein the discharge process is Fowler-Nordheim tunneling.

25. The horological device of claim 22 wherein the charging process is channel hot electron injection.

26. The horological device of claim 22 further comprising:

a charge injector for injecting charge through the insulating medium into the internal medium.

27. The horological device of claim 26 further comprising:

a programming unit for programming the charge storage element by operating the charge injector.

28. The horological device of claim 27 further comprising:

a request processing unit for processing requests to program the charge storage element.

29. The horological device of claim 27 further comprising:

a status generating unit for generating status from programming the charge storage element.

30. The horological device of claim 22 wherein the charge storage element is a floating gate in a floating gate field effect transistor.

31. A method for using an horological device, the method comprising:

programming a charge storage element by storing an electrostatic charge within the charge storage element, wherein the charge storage element comprises an internal medium for storing an electrostatic charge and an insulating medium for insulating the internal medium,

wherein the insulating medium substantially surrounds the internal medium;

wherein the insulating medium has physical properties that allow a charging process for charging the internal medium with an electrostatic charge through the insulating medium;

wherein the insulating medium has physical properties that allow a discharge process for discharging a stored electrostatic charge from the internal medium through the insulating medium;

wherein the insulating medium has one or more physical properties that affect a rate of discharge in the discharge process; and

wherein at least one physical property of the insulating medium has been selected so that the discharge process discharges a stored electrostatic charge at a predetermined rate; and

discharging the stored electrostatic charge from the charge storage element.

32. The method of claim 31 further comprising:

programming the charge storage element by injecting charge through the insulating medium into the internal medium.

33. The method of claim 31 further comprising:

processing requests to program the charge storage element.

34. The method of claim 31 further comprising:

generating status after attempting to program the charge storage element.

35. The method of claim 31 wherein the charge storage element is a floating gate in a floating gate field effect transistor.

36. An horological device comprising:

a semiconductor substrate;

a source region;

a drain region;

a channel region between the source region and the drain region;

a control gate;

a floating gate between the control gate and the channel region; and

an insulating region comprising insulating material substantially surrounding the floating gate, wherein the insulating region comprises a tunneling region for discharging an electrostatic charge stored in the floating gate through a discharge process, wherein the tunneling region has one or more physical properties that affect a rate of discharge in the discharge process, and wherein at least one physical property of the tunneling region has been selected so that the discharge process discharges a stored electrostatic charge at a predetermined rate.

37. The horological device of claim 36 wherein the tunneling region is between the floating gate and the channel region.

38. The horological device of claim 36 wherein a selected physical property of the tunneling region comprises a selected thickness of the insulating material.

39. The horological device of claim 38 wherein the selected thickness of the tunneling region is less than 7 nanometers.

40. An horological device comprising:

a floating gate field effect transistor comprising a floating gate; and

an insulating region of insulating material adjacent to the floating gate, wherein a discharge rate of a discharge process that discharges an electrostatic charge stored within the floating gate is inversely related to a thickness of the insulating region, and wherein the thickness of the insulating region is selected to cause a threshold voltage of the floating gate field effect transistor to reach a predetermined threshold voltage within a predetermined time period after programming the floating gate.

41. The horological device of claim 40 wherein a length of the predetermined time period varies with an initial threshold voltage of the floating gate field effect transistor after programming the floating gate.

42. A method for using an horological device, the method comprising:

programming a floating gate field effect transistor, wherein the floating gate field effect transistor comprises a floating gate and an insulating region of insulating material adjacent to the floating gate;

discharging the floating gate, wherein a discharge rate of a discharge process that discharges an electrostatic charge stored within the programmed floating gate is inversely related to a thickness of the insulating region, and wherein the thickness of the insulating region is selected to cause a threshold voltage of the floating gate field effect transistor to reach a predetermined threshold voltage within a predetermined time period after programming the floating gate.

43. The method of claim 42 wherein a length of the predetermined time period varies with an initial threshold voltage of the floating gate field effect transistor after programming the floating gate.

44. A computer program product on a computer readable medium for use in a data processing system for using an horological device, the computer program product comprising:

instructions for programming a floating gate field effect transistor, wherein the floating gate field effect transistor comprises a floating gate and an insulating region of insulating material adjacent to the floating gate, wherein a discharge rate of a discharge process that discharges an electrostatic charge stored within the programmed floating gate is inversely related to a thickness of the insulating region, and wherein the thickness of the insulating region is selected to cause a threshold voltage of the floating gate field effect transistor to reach a predetermined threshold voltage within a predetermined time period after programming the floating gate; and

instructions for performing a read operation on the floating gate field effect transistor to determine whether or not the predetermined time period has elapsed based on whether or not the floating gate field effect transistor has reached the predetermined threshold voltage.

45. The computer program product of claim 44 wherein a length of the predetermined time period varies with an initial threshold voltage of the floating gate field effect transistor after programming the floating gate.

46. An article of manufacture comprising:

a binary time cell; and

circuitry for allowing a state of the binary time cell to be modified or read.

47. The article of manufacture of claim 46 wherein the binary time cell has a substantially discharged state before a programming operation and has a controlled discharge state after the programming operation, and wherein the binary time cell transitions after the programming operation from the controlled discharge state to the substantially discharged state within a predetermined time period after the programming operation.

48. The article of manufacture of claim 46 wherein the article of manufacture is a smart card.

49. The article of manufacture of claim 46 further comprising:

coupling means for coupling the article of manufacture to a reading device or programming device.

50. The article of manufacture of claim 46 further comprising:

time determining means for determining whether or not a predetermined time period has elapsed since the binary time cell was programmed.